ATM– Historic Background

Francisco Javier Sáez Nieto

COURSE 102: RESEARCH IN DECISION SUPPORT SYSTEMS FOR FUTURE AIR TRAFFIC MANAGEMENT

Content:

- Genesis of the air navigation
- The first steps
- The air navigation development process
  - *Institutional international development*
  - *Operational development*
  - *Technological development*
- Conclusion

Genesis of the ATM

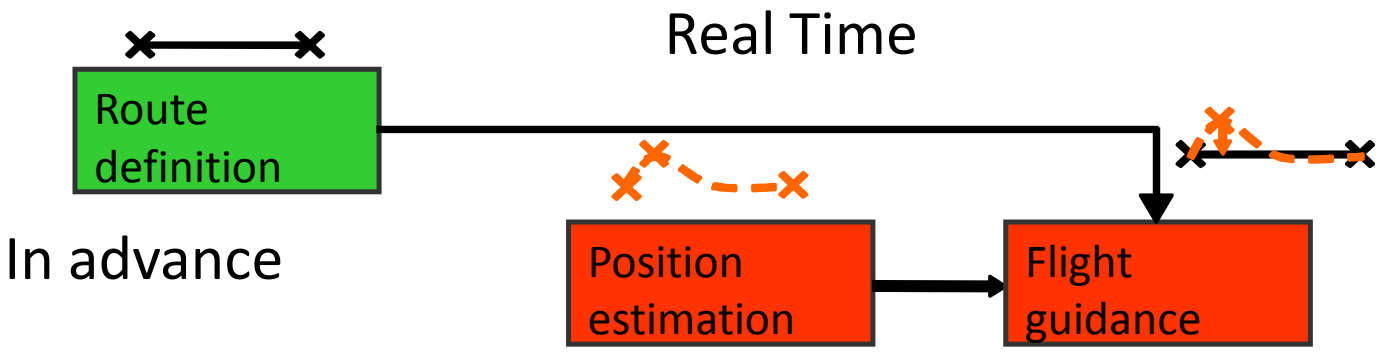
The Goal:

- Minimize the effects of three threats:
  - *Get lost*,
  - *Collide (with other aircraft or ground)* and
  - *Effects of adverse weather conditions that prevent aircraft from continue the flight safely*

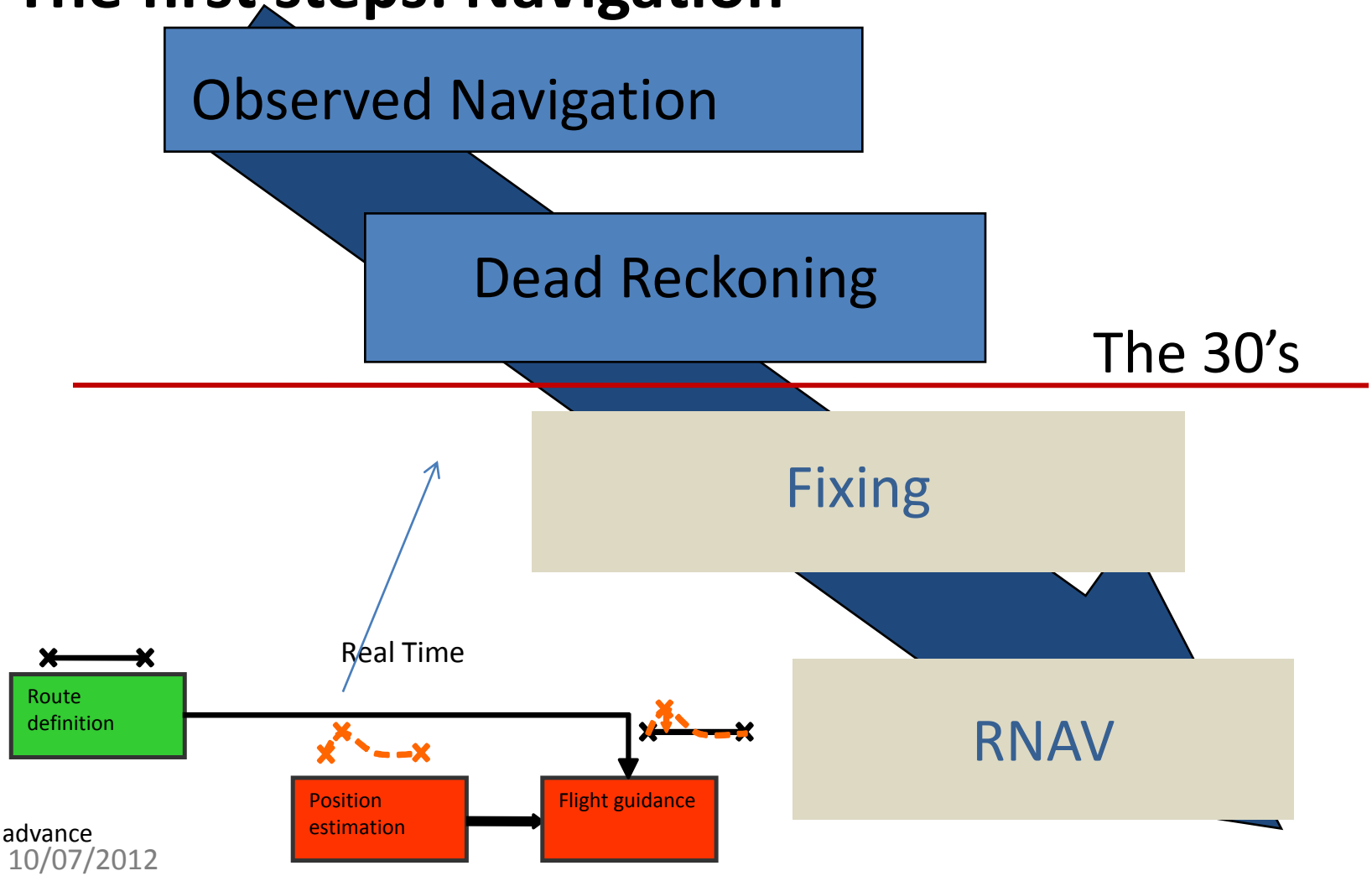
Genesis of the ATM

The Functions:

- *Planning*, the flight to be carried out (Flight Plan),
- *Positioning* at all times in relation to the flight plan
- *Guiding* the aircraft close to the planned flight.

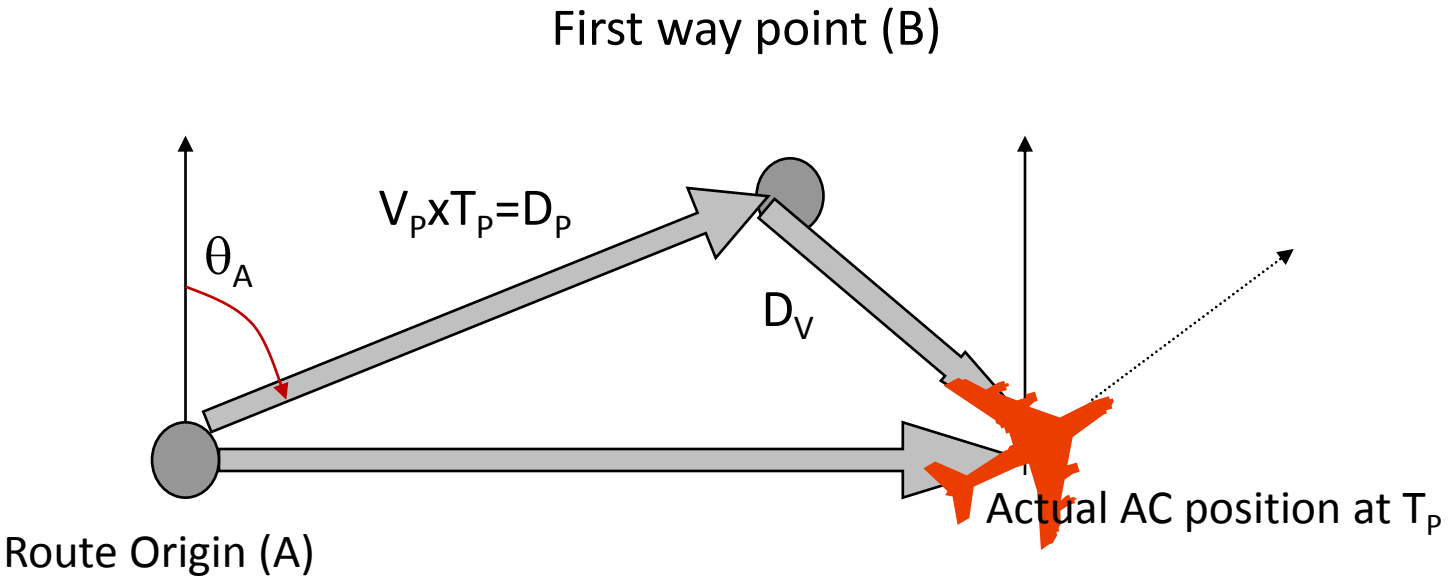


The first steps: Navigation



The first steps: Navigation

Velocity triangle; Heading and Track angles



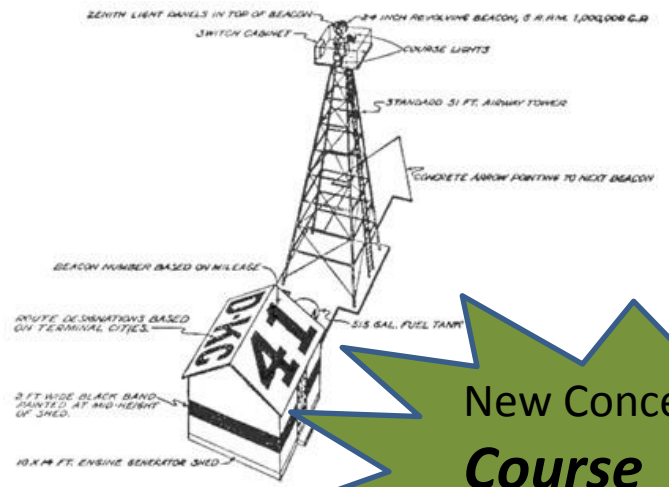
The first steps: Navigation

Observed Navigation

Dea

Fixing

The 30's



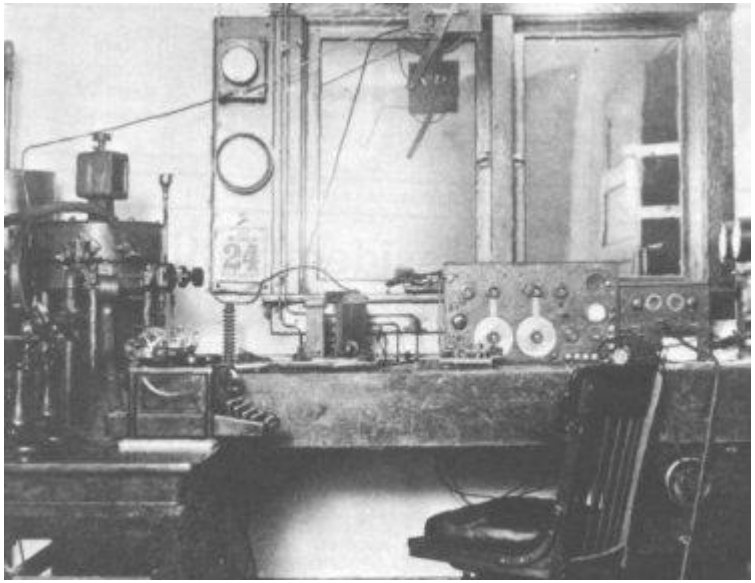
Fixing

New Concept:
Course

RNAV

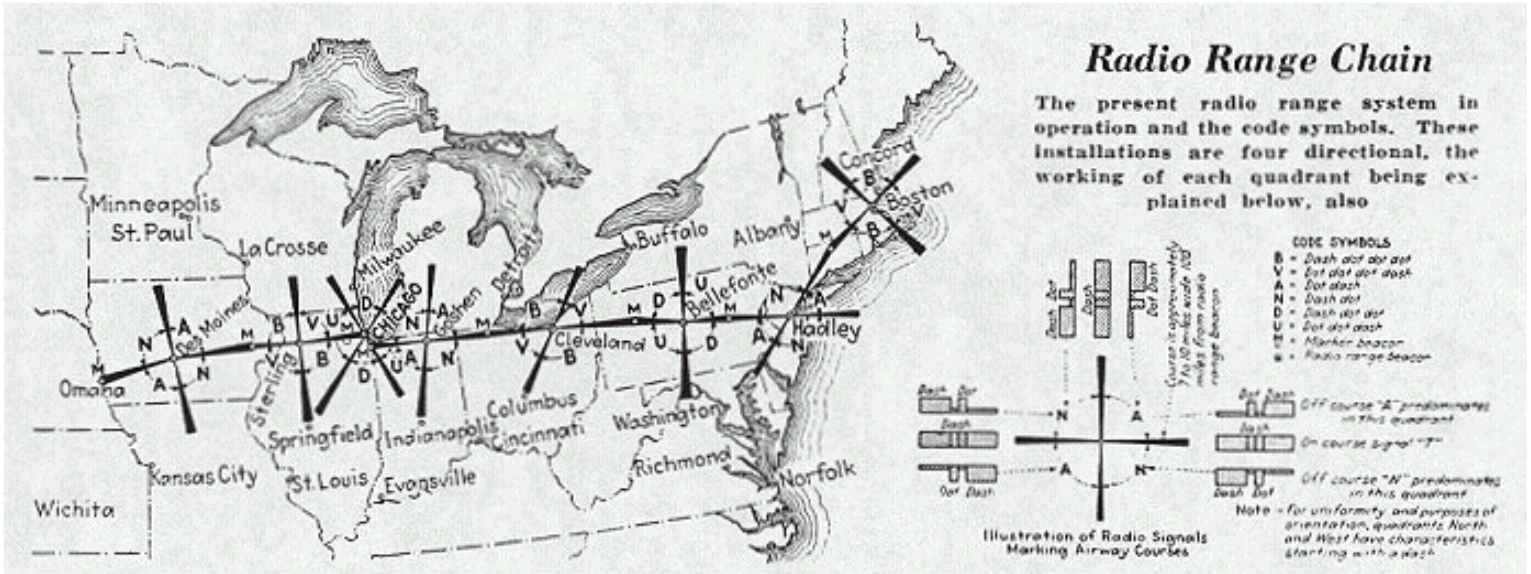
The first steps: All weather operations.

In October 1928, the Aeronautics Branch installed a group of new radio stations to complement the 17 it had inherited from the Postal Service. It also began sending voice information to help pilots navigate, first by radiotelegraphy and then by teletypewriter. By the end of 1934, there were 68 communications stations and many pilots could request navigation help by two-way radio.



http://www.faa.gov/about/media/b-chron.pdf

The first steps: All weather operations.



In 1928, the Bureau of Standards also developed a radio navigation beacon system, and in 1929 the Aeronautics Branch standardized a four-course radio range whereby pilots listened to audio signals to determine if they were on course.

First radio Navaid:

Radio range

The first steps: All weather operations.

"As early as 1923, **blind landing** tests had been initiated by the Bureau of Standards for the Army Air Service. Famed aviator Jimmy Doolittle had conducted a ...“
He worked with the Guggenheim Flight Laboratory in developing instruments for flight in poor weather. **On September 24, 1929**, he was the first person to take off, fly and land an airplane entirely by instruments.

- **The first steps: All weather operations.**

Jul 1, 1928: The Commerce Department began using teletype machines to transmit aviation weather information. Those units were all connected with the central office at Washington, D.C., from which data were exchanged for all locations.

- **The first steps: Airway Traffic Control**

In December 1935, an airline consortium opened the first Airway Traffic Control Station for keeping aircraft safely separated as they moved between airports. Photo 4 shows operations at this Newark, N.J., facility during the following year.

The pointed markers representing aircraft were moved across the map as flights progressed. First developed by controller J. V. Tighe, these markers came to be known as "shrimp boats."

http://avstop.com/history/atc/air_traffic_control_begins.htm

The first steps: Summary

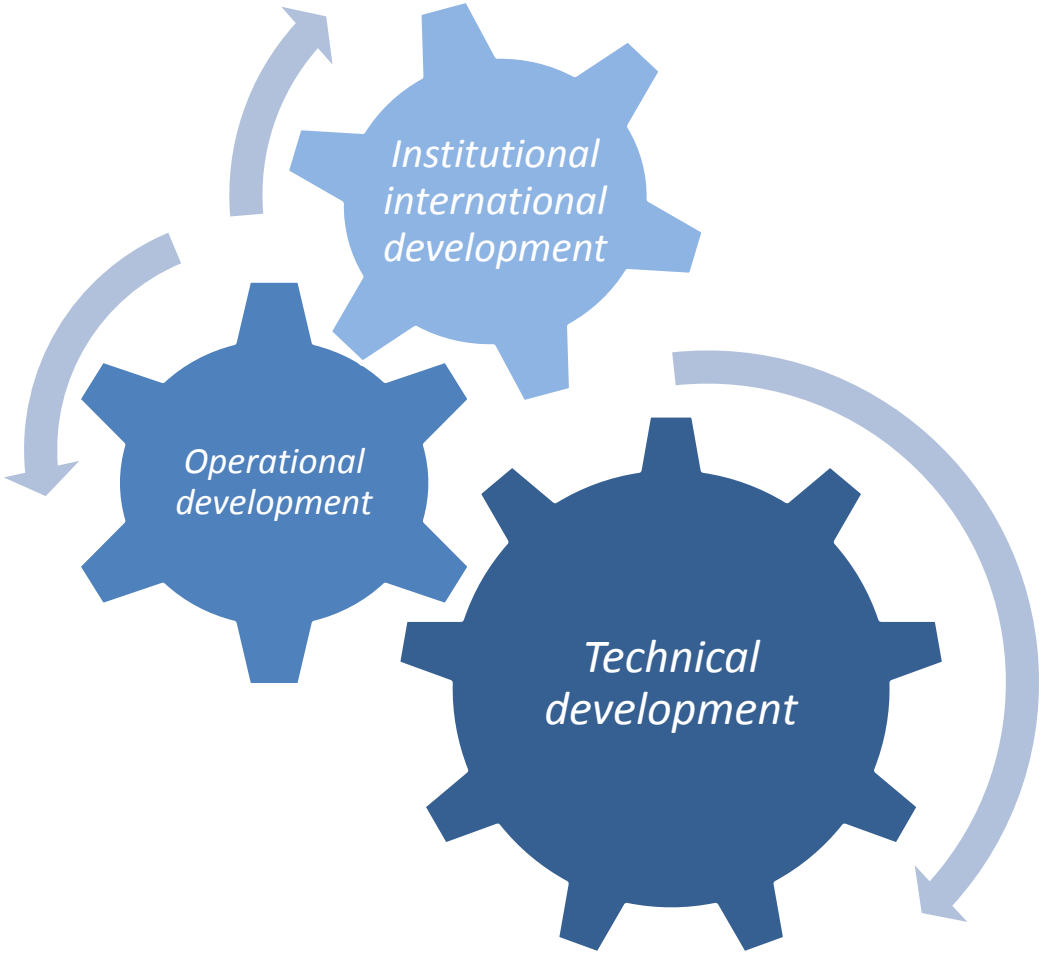
Components of the air navigation system:

An information system to support pre-flight planning containing weather information and possible operational limitations in the aerodromes and in Navaids.

Tactical support to the pilots, prevailing on possible modifications in the operational state of the environment and on possible risks of collision with other aircraft,

Telecommunications facilities for navigation of the aircraft and Air Ground communication.

The air navigation development process.



Institutional international development

Year 1910:

By invitation of France,
was held in Paris the **first Conference on international air law**. This Conference was attended by **18 European countries** established a number of principles on the regulations required at the international level for the development of air navigation.

Aviation fair - Paris 1909

Institutional international development

Year 1919:

Paris Peace Conference,
taking into account an inter-aliado Aeronautics Committee, created in 1917 initiatives.
This action then resulted in the drawing up of the International Air Convention, which **was signed by 26** of the 32 Allied and Associated powers represented at the Paris Peace Conference and was ultimately ratified by 38 States. **This Convention consisted of 43 articles** that dealt with all **technical, operational and organizational aspects** of civil aviation and also foresaw the **creation of an International Commission for Air Navigation** (**ICAN**) to monitor developments in civil aviation and to propose measures to States to keep abreast of developments.

Institutional international development

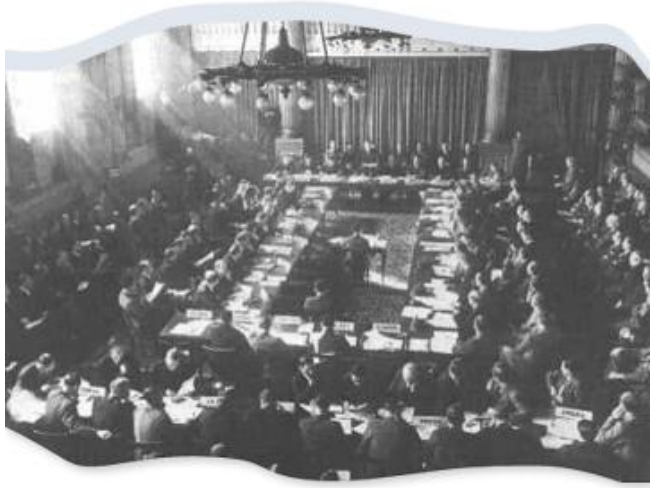
Problems of the ICAN:

- Convention not ratified by **United States** or **Russia**.
- **Spanish-speaking countries** formed a rival organization called Ibero-American Convention of the air, and then Pan American Convention of commercial aviation (or Havana Convention).
- This organism finally **disappeared in 1946** as result of the creation of ICAO.

Opening meeting of ICAN first Session held at Quai d'Orsay, Paris, France on 11 July 1922.

Institutional international development

November 1944:
United States invited **55 States** to hold an International Conference on aviation in Chicago. This Conference was attended by 54 States. **32 States agreed to the permanent establishment of an international organization of aviation** as an instrument to ensure international cooperation, uniformity in regulations and rules, procedures and organization on civil aviation issues.



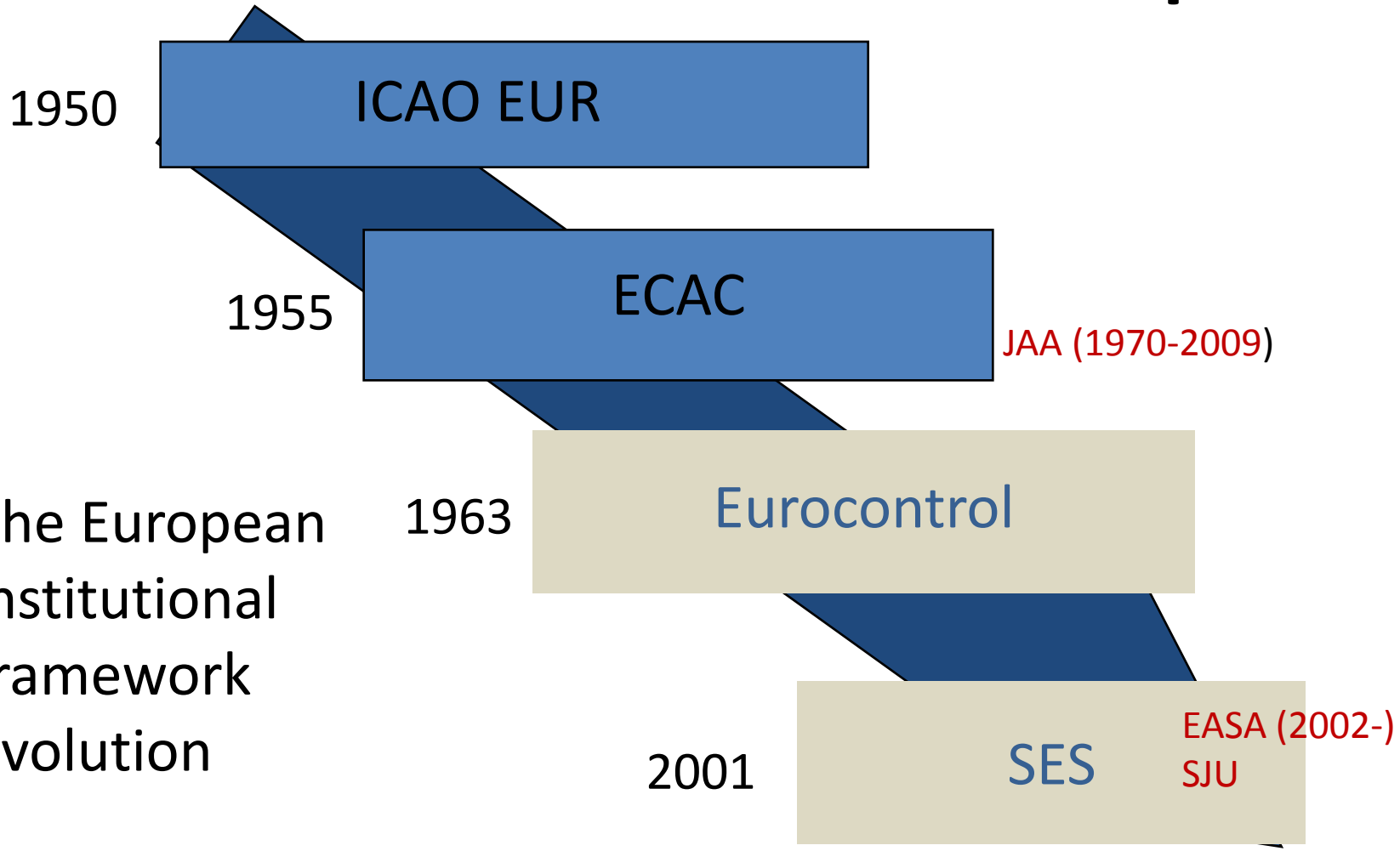
PICAO - North Atlantic Route Service Conference
(Dublin, March 1946)

Institutional international development

First ICAO Rules and standards:

- training and licensing of aviation personnel
- systems and communications procedures
- rules on systems, rules of the air and on the air traffic control
- requirements for airworthiness, registration and identification for aircraft that fly internationally
- aeronautical meteorology, maps and navigation charts.

Institutional international development



The European institutional framework evolution

Institutional international development

Summary:

- In the fifties the worldwide international civil aviation institution was completely developed.
- Three attempts have taken place in Europe (ECAC (50s), Eurocontrol (60/70s) and SES initiative(2000s)), significant lack of coherence among the air navigation European institutions is observed.

Operational development

In March 1947,

At the initiative of the newly created ICAO in order to limit the volume of airspace associated with the aerodrome air traffic control, (Airport Traffic Zone ATZ) aerodrome control zones were established, these areas were defined with a radius between 3 and 5 nautical miles

Operational development

In January 1952

It was applied for the first time at Washington control center, “radar control procedures” for outbound traffic. From the same center, in June of this year started to use radar for “approach control”.

Operational development

In 1952/53

it was implemented, on the initiative of the ICAO new phonetic alphabet which used words with a similar pronunciation in all languages. Also, the ICAO adopted the recommendation of the use of English as the most suitable for transmitting aeronautical transmissions. This recommended practice was incorporated in an amendment to annex 10 to the Convention in April 1953.

A	ALPHA	N	NOVEMBER
B	BRAVO	O	OSCAR
C	CHARLIE	P	PAPA
D	DELTA	Q	QUEBEC
E	ECHO	R	ROMEO
F	FOXTROT	S	SIERRA
G	GOLF	T	TANGO
H	HOTEL	U	UNIFORM
I	INDIA	V	VICTOR
J	JULIET	W	WHISKEY
K	KILO	X	X-RAY
L	LIMA	Y	YANKEE
M	MIKE	Z	ZULU

Operational development

In May 1958

There was one of the **most important facts in the history of ATM**, as it was the modification of the rule "see and be seen" as a philosophy for the development of the flights. This rule remained valid only for "VFR" flights. Special regulation 424, which allowed the establishment of "segments of route with positive control" in any part of the air space between 17000 and 35000 feet and a width of not more than 40NM was adopted. When a space designated in this way, the VFR flights were prohibited, allowing only IFR operations

Operational development

In 1959

The secondary radar for civil uses: between 1960 and 1961 the FAA tested successfully the **radar area positive control**, this control was extended in an area of about 500000 Km2 between 24000 and 35000 feet and served from the centers of Chicago and Indianapolis. Any aircraft entering into this airspace required radio equipment that allowed communication with the control centers and, in addition, radar "transponder" for the identification of the aircraft, on the radar display. This type of control allowed to reduce the minimum separation between aircraft at less than half of the existing standard value until then.

Operational development

Between the years 1964 and 65

ILS category II were in operation, this meant the reduction up to 100 feet of the decision height, corresponding with horizontal visibility of 400 m. Previously, these operations required 200 feet and about 800 m, respectively.

in June 1965 under low visibility operations conditions a British aircraft in scheduled flight with passengers made the first automatic landing at Heathrow.

Operational development in April 1970

The first centralized ATFM unit was established in Washington. ATFM activities with five units which coordinated their activities among themselves began in Europe in the 1970s. With the crisis of the airline in Europe in 1988, at the initiative of the CEAC, it was decided the creation of a single unit (CFMU) in Brussels which was fully operational in 1996.

The extensive use of the positive control and randomness and contingencies to which air traffic operations are subject, produced very important oscillations in the activities of the controllers, giving strong "stress" situations. This fact drove the establishment of organizations for the air traffic flow control of (Air Traffic Flow Management ATFM).

Operational development

In 1974 FAA published a regulation requiring the installation of system **GPWS** (Ground Proximity Warning System) in heavy aircraft. This system provides visual and audible information to the crew when the aircraft descends below the 2500 feet over the land.

In 1981 the FAA adopts a system on board called Traffic Alert and Collision Avoidance **TCAS**. It requires the existence of transponder secondary radar in all involved aircraft. This system arose as a response to a series of collisions between aircraft that had happened in the previous years.

Operational development

In 1991, the ICAO adopted a new classification for airspace, designating each type with a single letter, A to G. The objective was to establish a "standard" technical and operational requirements for air spaces with different demands of air traffic.

Operational development

In 1994

There were introduced two new concepts: **Free Flight** in USA and **Gate to Gate** in Europe. The RTCA development the Free flight concept and its primary aim was to provide greater flexibility to the IFR operations in high altitudes. Drivers would only intervene to ensure safety or to prevent congestion.

Meanwhile Europe developed the gate to gate concept (by Eurocontrol). It was focused on the continuity of aircraft operation, since it starts its interaction with the ATM, until this ends.

Operational development

Summary:

- **Navigation:** From routes based on the position of the ground infrastructure to RNAV/PBN.
- **Air Traffic Control:**
  - From procedural (conventional) to radar control,
  - From aeronautical information reports, advisories reports, to clearances (1958),
  - Alerting systems were added on board (60/70s) to improve safety.
- **ATM:** From ATC only to ATC+ATFM (70s)

Technological development

In June of 1927:

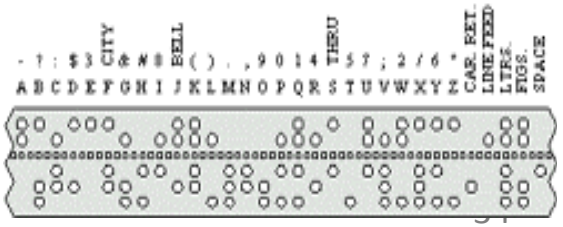
already 4121 miles of airways delimited by light beacons existed in the USA.

Technological development

In 1928:

The development of the first radio electric system for air navigation was culminated successfully and denominated “Range Radio”.

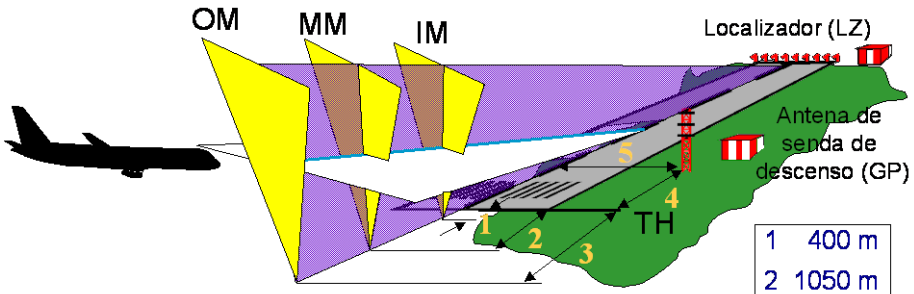
The teletypes for meteorological information dissemination of aeronautical interest in the aerodromes were introduced. These machines were connected to each other through a network, whose central knot was located in Washington.



Technological development

In 1933 :

The development of the predecessor of the instrument landing system (ILS) was completed, it became a standard by the office of Aeronautical Commerce the USA in September of 1934.



1	400 m
2	1050 m
3	7500 m
4	300 m
5	120 m

OM: Baliza Exterior: 75 MHz (400 Hz)

MM: Baliza Intermedia: 75 MHz (1300 Hz)

IM: Baliza Interior: 75 MHz (3000 Hz)

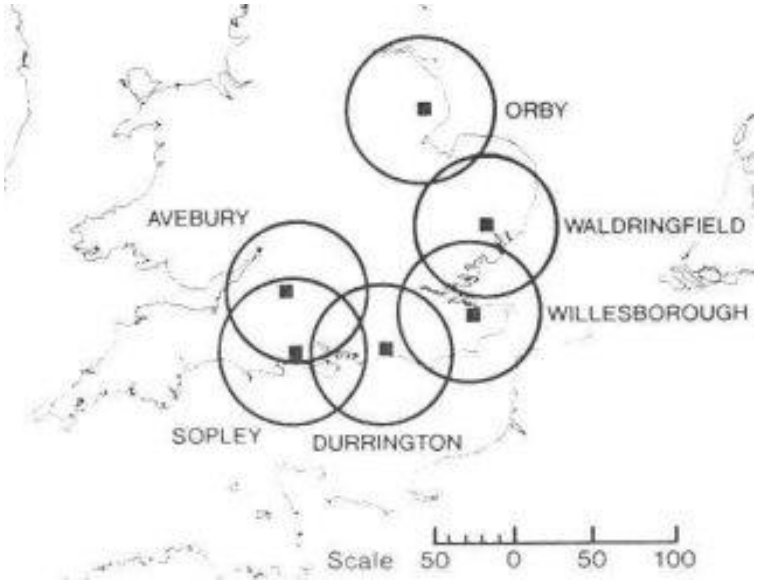
LZ: Localizador: 108 - 112 MHz (AM: 1020 Hz, 90 & 150 Hz)

GP: Senda de Planeo: 329 - 335 MHz (AM: 90 & 150 Hz)

Technological development

In 1935:

An important milestone in the history of the air navigation was registered. The British Secretary of Defense received a technical report about what today it is known as Radar. This system was used in II the world war by the British who had a chain of unfolded radar stations. During the IIWW the secondary radar (SSR) was developed.



Technological development

In 1941:

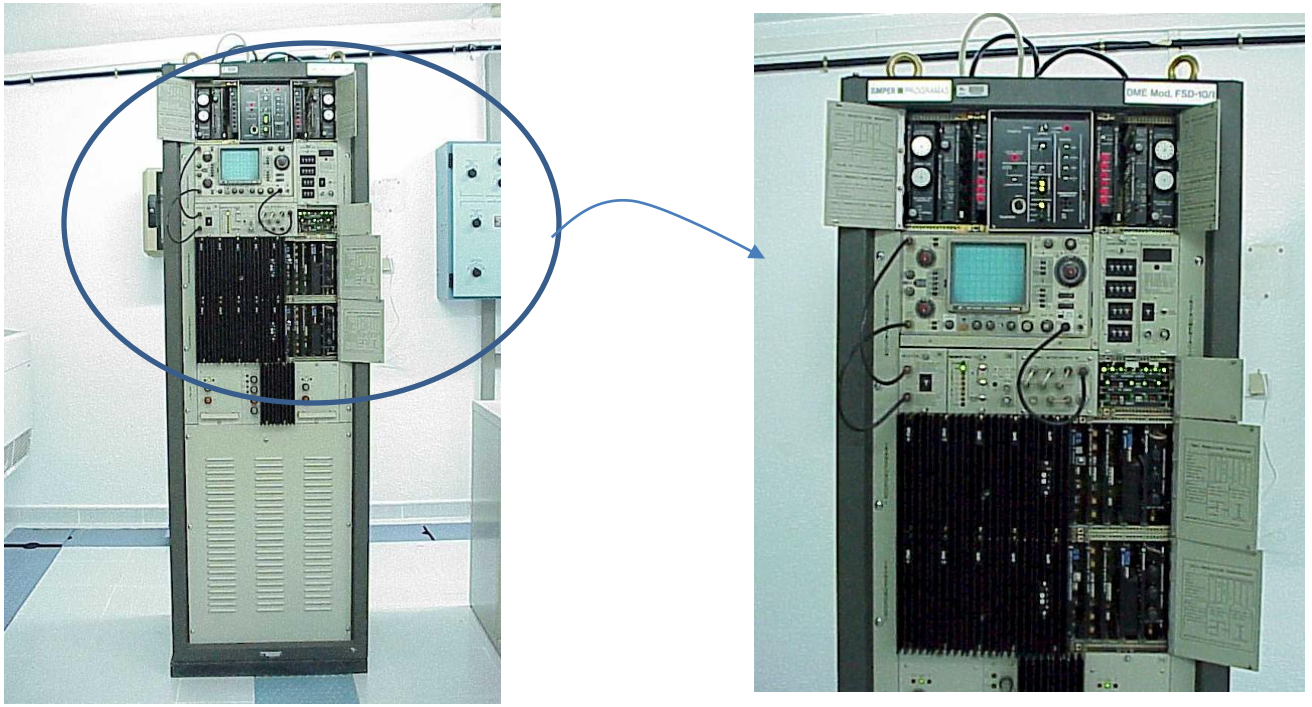
After a year of tests, it was installed the first VHF omnidirectional beacon to be used by regular airliners between New York and Chicago.

In 1944 the VOR was totally operative.

Technological development

In 1950:

The deployment of ground equipments DME began (Distance Measuring Equipment) to improve the Victor's network of airways.



Technological development

In 1955

The first “automatic pilot” of solid state for the civil aviation was developed by Bendix Aviation Corporation, the tests were made on installed prototypes on a B-25.

Technological development

In 1960,

The radar “bright display” for the presentation of radar data in spaces having more light than the one than it was possible using the old displays.

ASDE radars were also introduced.

Technological development

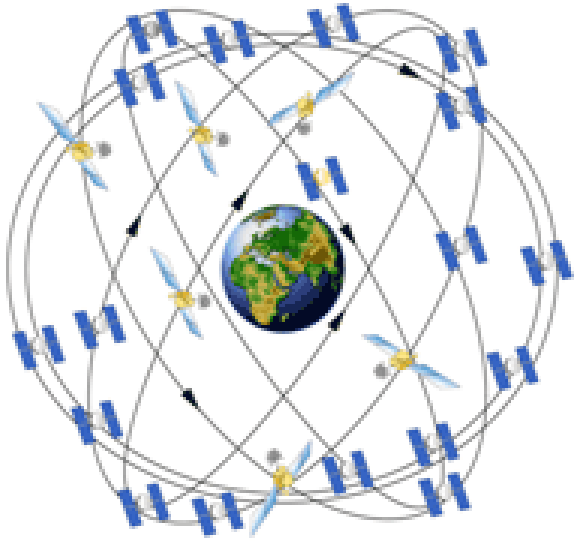
In June of 1961

The limitations of the VOR in “non ideal” geographical locations, demanded the technical development of other “equivalent” ground equipments able to overcome with this limitation, thus the FAA acquired the first VOR Doppler.

Technological development

In May of 1983:

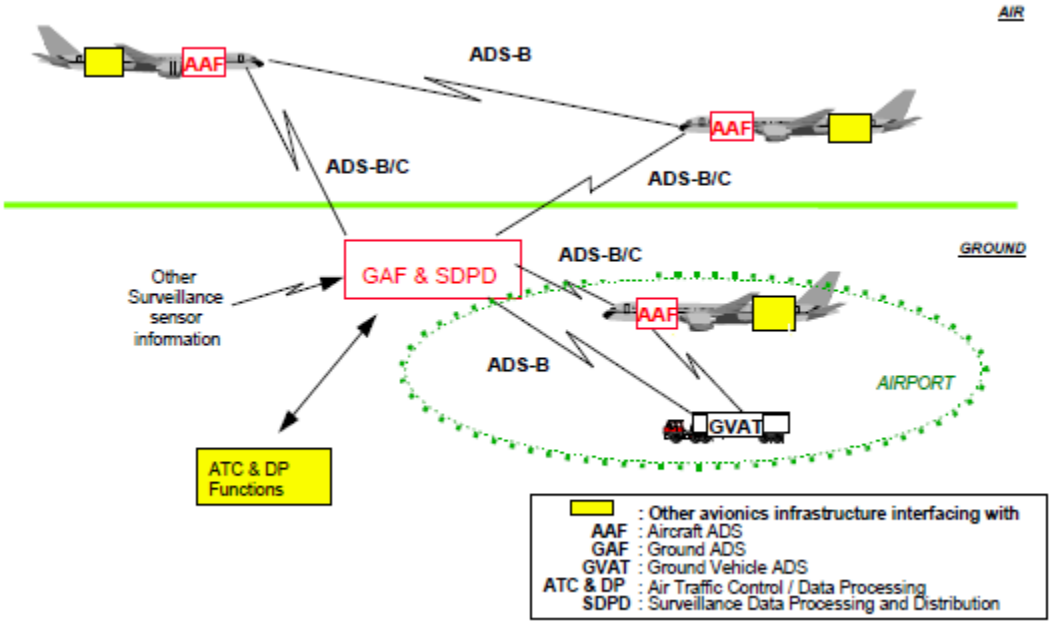
the first transatlantic flight that used as navigation means the GPS, showing its potential to become basic means for the future of the air navigation.



Technological development

In the mid-1990s:

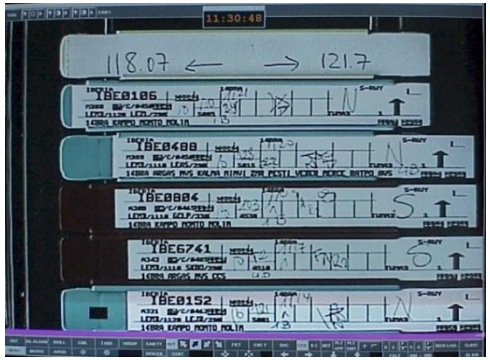
It was planned a "*transition from ground-based radar surveillance to a joint satellite-based and ground-based surveillance system*". The system has evolved from lessons learned from prototypes starting in early 2000s being known as ADS.



Technological development

Summary:

- ❑Communications:
  - ➢T/A: Voice comms still in use
  - ➢G/G: From AFTN to AMHS/ATN (SWIM?)
- ❑Navigation: From Victor Airways to RNAV and from manual guidance to FCS and FMS.
- ❑Surveillance: From procedural to radar surveillance using ground based radars + ADS



Conclusion:

- A high level of automation has been achieved on board aircraft for navigation purposes.
- Alerting systems to support aircraft safety are already in operation.
- In terms of air traffic management the degree of evolution has been very poor.
- A lack of air ground system integration is clearly observed.

Thank you for your attention!